SPACECRAFT TELECOMMUNICATIONS TECHNOLOGY FOR MICROSPACECRAFT APPLICATIONS

K. Kellogg and C. Kyriacou
Jet Prepulsion, Laboratory, California Institute of Technology
Pasadena, California 91109

ABSTRACT

Spacecraft telecommunications systems traditionally consist of Radio Frequency Subsystems (RFS) and Antenna Subsystems. Fundamental trade-offs in system design are between power consumption, frequency and antenna size. Higher frequencies, such as Ka-band, result in systems with higher data rates, and low volume and mass, and enable use of electrically large antennas in a small physical envelope. These systems are at the state of the art for deep space telecommunications and are very costly to implement.

Development and space qualification of the following critical RFS technologies will yield significant savings to mass and volume, with lower cost than is available today. Application and integration with Microwave Monolithic Integrated Circuit (MMIC) devices with improvements in reliability through higher levels of integration, can reduce volume requirements by an order of magnitude; however, this technology is not space qualified at deep spare frequencies. Research is also needed into rigorous modeling of MMIC packages and devices to reduce production iterations and to understand device interaction. Increased use of Application Specific Integrated Circuits (ASICs) to implement digital functions within the Transponder, Telemetry Control Unit and Command Detector Unit will likewise reduce mass and volume; however, research is needed to develop low power consumption MMIC and digital devices.

Antenna performance will dramatically benefit by development of space qualified MMICs for active array applications. Active arrays can replace bulky, massive TWTs and their associated high voltage power supplies by placing both the power amplifiers and low noise amplifiers at the aperture. Such arrays have the flexibility to be used as stand-alone small- to medium-sized apertures or to be used as feeds for reflector systems to efficiently realize larger aperture sires. A key design challenge to implementing this technology is to provide a suitable thermal Environment for the active components. Optically Processed Beamforming (OPB) is the ultimate step in increasing overall telecommunications system flexibility and reducing system mass. OPB removes RF processing and components between the transponder and active aperture; transmission and distribution of signals to and from the aperture is accomplished photonically. Research is needed to develop photonic devices and tools to accurately model them in telecommunication system applications.